

APPARATUS AND METHOD FOR REMOTELY AND  
AUTOMATICALLY CONTROLLING THE VOLUME OF AUDIO  
SIGNALS PRODUCED BY A REMOTELY CONTROLLED AUDIO DEVICE

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT (1) ROBERT V. BELENGER, employee of the United States Government, and (2) GENNARO R. LOPRIORE, citizens of the United States of America and residents of (1) Raynham, County of Bristol, Commonwealth of Massachusetts and (2) Somerset, County of Bristol, Commonwealth of Massachusetts, have invented certain new and useful improvements entitled as set forth above of which the following is a specification:

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PATENT TRADEMARK OFFICE

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3 APPARATUS AND METHOD FOR REMOTELY AND  
4 AUTOMATICALLY CONTROLLING THE VOLUME OF AUDIO  
5 SIGNALS PRODUCED BY A REMOTELY CONTROLLED AUDIO DEVICE  
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7 STATEMENT OF GOVERNMENT INTEREST

8 The invention described herein may be manufactured and used  
9 by or for the Government of the United States of America for  
10 governmental purposes without the payment of any royalties  
11 thereon or therefor.  
12

13 BACKGROUND OF THE INVENTION

14 (1) Field Of The Invention

15 The present invention generally relates to an apparatus and  
16 method for remotely and automatically controlling the volume of  
17 audio signals generated by a remotely controlled audio device.

18 (2) Description of the Prior Art

19 Remote control units are typically sold with television  
20 ("TV") sets and AM/FM radios. Remote control units are generally  
21 described in U.S. Patent Nos. 4,221,006, 5,005,084 and 5,774,187.  
22 However, there are many other designs of remote control units  
23 that are now commercially available. Typically, the remote  
24 control unit communicates with circuitry within the audio device

via transmitted signals that are encoded with particular sequences that define specific functions. Remote control units provide users with the capability to activate or deactivate the audio device, increase or decrease the volume, change channels or frequencies, mute the audio signals, and store commonly used channel or frequency information. Universal remote control units further include control functions that pertain to video cassette recorders and cable converter boxes. Most remote control functions, such as the channel-changing function, require no further adjustments after a channel has been selected. However, the volume control circuitry of conventional remote control units does not have a reference audio volume. Thus, the user must frequently vary the volume in order to find a comfortable volume level. For example, different TV stations broadcast signals having varying audio levels. Thus, the audio level varies as the user changes channels. In another example, the audio level associated with commercial ads is significantly higher than the audio level associated normal TV programs. As a result, the audio level is never constant.

#### SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an apparatus and method for remotely and automatically

1 adjusting the volume of a remotely controlled audio device that  
2 eliminates the foregoing problems.

3 Other objects and advantages of the present invention will  
4 be apparent to one of ordinary skill in the art in light of the  
5 ensuing description of the present invention.

6 The present invention is directed to, in one aspect, an  
7 apparatus for remotely and automatically adjusting the volume of  
8 a remotely controlled audio device. In one embodiment, the  
9 apparatus comprises a sensor circuit for detecting audio signals  
10 generated by the audio device and generating a signal  
11 representative of the amplitude of the detected audio signal, a  
12 difference circuit for determining the difference between the  
13 amplitudes of the sensor circuit output signal and a reference  
14 audio signal and for generating a difference signal that  
15 represents this difference, a difference signal transfer circuit  
16 that has an input for receiving the difference signal and an  
17 output wherein the transfer circuit transfers the difference  
18 signal to the output when the sensor circuit output signal  
19 indicates detection of an audio signal, and a control circuit  
20 having an input connected to the output of the transfer circuit  
21 wherein the control circuit generates a control signal that  
22 effects attenuation, augmentation or maintenance of the amplitude  
23 of the audio signals generated by the audio device in accordance

1 with the difference signal when the sensor circuit detects an  
2 audio signal.

3 In one embodiment, the sensor circuit comprises a  
4 directional microphone for detecting audio signals outputted by  
5 the device.

6 In one embodiment, the difference circuit further comprises  
7 an analog-to-digital-converter for converting the detected audio  
8 signals into digital data and digital circuitry for storing  
9 digital data representing the reference audio signal amplitude.

10 The circuitry of the control circuit is configured to  
11 generate a control signal that effects:

12 (a) attenuation of the amplitude of the audio signals  
13 generated by the audio device when the amplitude of the sensor  
14 output signal exceeds the reference audio signal amplitude by  
15 a predetermined magnitude;

16 (b) augmentation of the amplitude of the audio signals  
17 generated by the audio device when the reference audio signal  
18 amplitude exceeds the amplitude of the sensor output signal by  
19 a predetermined magnitude; and

20 (c) maintenance of the amplitude of the audio signals  
21 generated by the audio device when the amplitude of the sensor  
22 output signal is substantially the same as the reference audio  
23 signal amplitude.

1 In yet a further aspect, the present invention is directed  
2 to a method for remotely and automatically adjusting the volume  
3 of a remotely controlled audio device, comprising the steps of  
4 detecting audio signals generated by the audio device and  
5 generating a signal representative of the amplitude of the  
6 detected audio signal, determining the difference between the  
7 amplitude of signal generated in the detecting step and a  
8 reference audio signal amplitude and generating a difference  
9 signal representing that difference, and generating a control  
10 signal that effects attenuation, augmentation or maintenance of  
11 the amplitude of the audio signals outputted by the audio device  
12 in accordance with the difference signal when the sensor circuit  
13 detects an audio signal.

#### 14 15 BRIEF DESCRIPTION OF THE DRAWINGS

16 The features of the invention are believed to be novel and  
17 the elements characteristic of the invention are set forth with  
18 particularity in the appended claims. The figures are for  
19 illustration purposes only and are not drawn to scale. The  
20 invention itself, however, both as to organization and method of  
21 operation, may best be understood by reference to the detailed  
22 description which follows taken in conjunction with the  
23 accompanying drawings in which:

1 FIG. 1 is a block diagram of the apparatus of the present  
2 invention; and

3 FIG. 2 is a block diagram showing component details of the  
4 apparatus of the present invention.  
5

#### 6 DESCRIPTION OF THE PREFERRED EMBODIMENT

7 In describing the preferred embodiments of the present  
8 invention, reference will be made herein to FIGS. 1 and 2, in  
9 which like numerals refer to like features of the invention.

10 The present invention provides an apparatus and method for  
11 remotely and automatically adjusting the volume of audio signals  
12 generated by an audio device having a control signal receiver  
13 that enables the audio device to be remotely controlled. Such  
14 audio devices include remote controlled televisions, radios,  
15 stereos, or any other devices that produce audio signals and  
16 which can be remotely controlled.

17 Referring to the FIG. 1, apparatus 10 of the present  
18 invention generally comprises sensor circuit 12, difference  
19 circuit 14, difference signal transfer circuit 16 and control  
20 circuit 18. Sensor circuit 12 is configured to continuously  
21 detect audio signals 19 generated by audio device 20 (shown in  
22 phantom) and output signal 22 that has a magnitude that is  
23 proportional to the magnitude of these detected audio signals.

1 In one embodiment, sensor circuit 12 comprises a directional  
2 microphone. Difference circuit 14 determines the difference  
3 between the amplitude of signal 22 and reference audio signal  
4 amplitude 24 and outputs a difference signal 26 that is  
5 representative of the difference between amplitude of signals 22  
6 and 24. Transfer circuit 16 is activated upon generation of  
7 signal 22 by sensor circuit 12, as shown by activation signal  
8 22a. When activated, transfer circuit 16 transfers the  
9 difference signal 26, now represented by signal 28, to control  
10 circuit 18. Control circuit 18 generates control signal 30 that  
11 effects attenuation, augmentation or maintenance of the amplitude  
12 of the audio signals 19 generated by audio device 20 in  
13 accordance with the difference signal 28. Each of these  
14 components of apparatus 10 is explained in detail in the ensuing  
15 description.

16 Referring to the FIGS. 1 and 2, in one embodiment, sensor  
17 circuit 12 comprises directional microphone 32 for detecting  
18 audio signals 19 outputted by audio device 20. Other  
19 commercially available acoustic or audio detectors also can be  
20 used. In one embodiment, directional microphone 32 outputs  
21 signal 33 that comprises a voltage that is proportional to the  
22 amplitude or level of the audio signals 19 outputted by the  
23 speakers (not shown) of the audio device 19. It is noted that



1 signal 22 may also comprise a proportional voltage signal. In  
2 one embodiment, sensor circuit 12 further includes audio signal  
3 amplifier 34. Amplifier 34 amplifies signals 33 outputted by  
4 directional microphone 32. In a preferred embodiment, amplifier  
5 34 is configured as a linear amplifier and has a sufficient  
6 signal-to-noise ratio that minimizes signal distortion. Whether  
7 amplifier 34 is utilized depends upon the proximity of apparatus  
8 10 to audio device 20.

9 Referring to FIGS. 1 and 2, in one embodiment, difference  
10 circuit 14 comprises analog-to-digital converter ("ADC") 36 which  
11 converts the amplified signals outputted by amplifier 34 into  
12 multi-bit digital signals 37. The number of bits in multi-bit  
13 digital signal 37 depends upon the desired precision. In one  
14 embodiment, ADC 36 outputs an eight-bit signal. Difference  
15 circuit 14 further comprises adder/subtractor circuit 38.  
16 Adder/subtractor circuit 38 outputs difference signal 26 that was  
17 described in the foregoing description. Specifically, difference  
18 signal 26 represents the difference between the audio signal  
19 amplitude represented by multi-bit signal 37 and reference or  
20 desired audio signal amplitude 24. In one embodiment, reference  
21 audio signal amplitude 24 is provided by a volume level control  
22 circuit 25 of a standard remote control unit which utilizes  
23 apparatus 10. In such a configuration, a user adjusts the volume

1 level control to provide a desired volume level. As a result,  
2 the aforementioned volume level control circuit outputs a multi-  
3 bit digital signal 24 that is inputted into adder/subtractor  
4 circuit 38. Difference signal 26 includes data that indicates  
5 whether the difference is negative or positive, i.e., whether the  
6 amplitude of signal 22 is greater or less than reference audio  
7 amplitude 24.

8 Referring to FIGS. 1 and 2, difference signal transfer  
9 circuit 16 includes a first input for receiving difference signal  
10 26 and a second input for receiving activation signal 22a.  
11 Difference signal transfer circuit 16 transfers or routes  
12 difference signal 26 to control circuit 18 when signal 22a  
13 indicates that an audio signal has been detected. In one  
14 embodiment, transfer circuit 16 includes circuitry that  
15 determines whether the amplitude of signal 22a pertains to a  
16 detected audio signal or the absence of an audio signal. If  
17 transfer circuit 16 determines that signal 22a indicates the  
18 absence of any audio signals, then transfer circuit 16 does not  
19 effect a transfer of difference signal 26, also indicated as  
20 signal 28 outputted by transfer circuit 16, to control circuit  
21 18. Thus, if a predetermined amount of time elapses in which  
22 signal 22a indicates the absence of audio signals, transfer  
23 circuit 16 terminates the transfer of the difference signal 28 to

control circuit 18. Such a configuration prevents apparatus 10 from interpreting the absence of detected audio signals as a need to increase the volume of the audio signals 19. Difference signal transfer circuit 16 can be realized by commercially available sound activation circuits. Other suitable circuitry can be used as well.

Referring to FIGS. 1 and 2, once difference signal transfer circuit 16 is activated, difference signal 26 is transferred or routed as signal 28 to control circuit 18. Control circuit 18 includes control circuitry 40 that effects comparison of difference signal 28 to a plurality of thresholds (e.g., threshold voltages) in order to determine whether there is a significant difference between the amplitudes of reference audio signal 24 and sensor circuit output signal 22, or whether the difference between the amplitudes is negligible.

In one embodiment, control circuit 18 is configured with digital circuitry that compares difference signal 28 to a plurality of threshold voltage levels wherein each threshold voltage is represented by a corresponding multi-bit digital signal. Specifically, control circuit 18 determines the magnitude of the difference between reference audio signal amplitude 24 and the amplitude of sensor circuit output signal 22, whether the amplitude of signal 22 is greater or less than

reference audio signal amplitude 24, the degree to which the volume of the audio signals 19 must be decreased or increased, and whether the volume of audio signals 19 is to be maintained at its current level.

Control circuit 18 then outputs multi-bit digital control signal 30 that is inputted into the volume control circuits 25 that are used in the standard remote control units. The volume control circuits 25 process control signal 30. Specifically, control signal 30 contains data that controls the volume control circuits 25 of the standard remote control unit to effect transmissions 27 of an encoded signal to audio device 20 that increases, decreases or maintains the volume of the audio signals 19. Control signal 30 controls the volume control circuits 25 of the standard remote control unit to maintain the current volume if the amplitude of signal 22 is generally the same as reference audio signal amplitude 24. In one embodiment, determining whether the amplitude of signal 22 is generally the same as reference audio signal amplitude 24 is accomplished by determining whether the amplitude of signal 22 is within a predetermined range of amplitudes wherein reference audio signal amplitude 24 is at the center of the predetermined range. For example, the reference audio signal amplitude 24 can be 100 millivolts and the predetermined range can be from 90 millivolts

1 to 110 millivolts. The volume of the audio signals 19 will be  
2 maintained if the amplitude of signal 22 is within the range of  
3 90 millivolts to 110 millivolts, inclusive.

4 In an alternate embodiment, control circuit 18 includes  
5 circuitry that is configured to implement the functions of  
6 difference signal transfer circuit 16. In a further embodiment,  
7 control circuit 18 is configured to include the volume control  
8 circuit 25 and to effect transmissions of the encoded signal as  
9 indicated by output signal 39.

10 In a preferred embodiment, apparatus 10 includes a switch 42  
11 that permits a user to either activate or deactivate the  
12 automatic volume control feature of apparatus 10. If the user  
13 configures the switch 42 to deactivate apparatus 10, the standard  
14 remote control unit functions in the normal or typical manner.  
15 Once the user configures the switch 42 so as to activate  
16 apparatus 10, the automatic volume control function of apparatus  
17 10 is implemented. In a preferred embodiment, after the user  
18 activates apparatus 10, the user maneuvers the standard remote  
19 control unit so that the directional microphone 32 (or other  
20 directional acoustic sensor) of sensor circuit 12 is pointed in  
21 the general direction of the speakers (not shown) of audio device  
22 20.

1        Although the ensuing description is in terms of apparatus 10  
2 being configured with digital circuitry, it is to be understood  
3 that apparatus 10 can be configured with analog circuitry. As  
4 shown by the foregoing description, a standard remote control  
5 unit can inexpensively be retrofitted to include apparatus 10.  
6 Alternatively, standard remote control units can be manufactured  
7 with apparatus 10 incorporated therein.

8        Thus, apparatus 10 of the present invention enables a user  
9 to monitor the acoustic or audio level outputted by speakers of  
10 the audio devices and compare that audio level to a reference or  
11 desired level that is manually inputted into the remote control  
12 unit by the user. As a result of such comparison, the audio  
13 level of the audio signals produced by the audio devices can be  
14 automatically increased, decreased or left unchanged.

15        Apparatus 10 provides many advantages and benefits, namely:

- 16            a) the volume of audio signals 19 is controlled  
17 automatically without the user having to continuously  
18 manually manipulate the volume control of the standard  
19 remote control unit;
- 20            b) audio device 20 does not have to be modified;
- 21            c) apparatus 10 can be realized with commercially  
22 available electronic components;
- 23

1           d) the automatic volume control feature of apparatus  
2           10 can be activated or deactivated without interfering with  
3           the normal operation of the standard remote control unit;

4           e) the physical arrangement of circuitry of apparatus  
5           10 within the standard remote unit can be varied to suit  
6           various standard remote control unit designs; and

7           f) standard remote control units can be retrofitted  
8           with apparatus 10 at a relatively low cost.

9           The principals, preferred embodiments and modes of operation  
10          of the present invention have been described in the foregoing  
11          specification. The invention which is intended to be protected  
12          herein should not, however, be construed as limited to the  
13          particular forms disclosed, as these are to be regarded as  
14          illustrative rather than restrictive. Variations in changes may  
15          be made by those skilled in the art without departing from the  
16          spirit of the invention. Accordingly, the foregoing detailed  
17          description should be considered exemplary in nature and not  
18          limited to the scope and spirit of the invention as set forth in  
19          the attached claims.